IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of

Gustavson, et al.

Serial No.:	10/671,933	**Group Art Unit:**	2193
Filed:	September 29, 2003	**Examiner:**	Do, Chat C.
For:	METHOD AND STRUCTURE FOR PRODUCING HIGH PERFORMANCE LINEAR ALGEBRA ROUTINES USING A HYBRID FULL-PACKED STORAGE FORMAT		

Commissioner of Patents
Alexandria, VA 22313-1450

APPELLANTS' BRIEF ON APPEAL

Sir:

Appellants respectfully appeal the rejection of claims 1, 4-6, 10, 13-15, 18, 19, and 26-28 in the Office Action mailed on June 20, 2007. A Notice of Appeal was timely filed on September 17, 2007.

I. REAL PARTY IN INTEREST

The real party in interest is International Business Machines Corporation, assignee of 100% interest of the above-referenced patent application, as evidenced by the assignment recorded at reel/frame 014548/0904.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to Appellants, Appellants' legal representative or Assignee which would directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

III. STATUS OF CLAIMS

Claims 1, 4-6, 10, 13-15, 18, 19, and 26-28 are all of the claims presently pending. Claims 2, 3, 7-9, 11, 12, 16, 17, and 20-25 are canceled.

Claims 1, 4-6, 10, 13-15, 18, 19, and 26-28 stand rejected under 35 U.S.C. § 101 as allegedly directed to non-statutory subject matter. There is no prior art rejection remaining in the prosecution of the pending claims.

This non-statutory subject matter rejection is being appealed for all pending claims.

IV. STATUS OF AMENDMENTS

A Request for Reconsideration Under 37 CFR §1.116 was filed on September 29, 2007. In the Advisory Action mailed on September10, 2007, the Examiner indicated that the arguments in the Request for Reconsideration Under 37 CFR §1.116 were not persuasive and that the rejection based on statutory subject matter was maintained for all claims.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention is directed to a method to at least one of reduce memory space requirement and/or to increase processing efficiency in a computerized method of linear algebra processing by providing a hybrid full-packed data structure, as provided for processing data of a triangular matrix by one or more dense linear algebra (DLA) matrix subroutines designed to process matrix data in a full format, as modified to process matrix data using the hybrid full-packed data structure. The hybrid full-packed data structure provides a compact rectangular full format data structure for an entirety of triangular

matrix data, wherein the triangular matrix comprises a triangular or symmetric/Hermitian matrix.

As explained on lines 9-16 of page 10 of the specification, the conventional dense linear algebra (DLA) data structures for triangular matrix data subroutines will either provide compact data storage along with slow processing speed or, alternatively, will provide faster processing speed but increased storage requirement.

In contrast, the present invention provides a method so that both compact storage and the faster processing speed are available. That is, the hybrid full-packed data structure taught by the present invention provides a full format storage of triangular matrix data that can be processed by the faster full-format subroutines, using these standard full-format subroutines as modified only in that a calling sequence is used that accommodates the novel data structure.

Bases in the specification for the claims:

1. (Rejected) A method to at least one of reduce a memory space requirement and to increase a processing efficiency in a computerized method of linear algebra processing (lines 9-10 of page 3 and lines 9-18 of page 5), said method comprising:

providing a hybrid full-packed data structure (300, Fig. 3) for processing data of a triangular matrix by one or more dense linear algebra (DLA) matrix subroutines designed to process matrix data in a full format (lines 3-7 and 10-12 of page 16), as modified to process matrix data using said hybrid full-packed data structure (402, Fig. 4; steps 509,510 of Fig. 5; line 10 of page 15 through line 2 of page 16); and

converting said data from said triangular matrix into said hybrid full-packed data structure (step 401, Fig. 4; steps 501-507 of Fig. 5; lines 8-10 of page 16), as follows:

determining a portion of said triangular matrix data that would comprise a square portion having a dimension approximately one half a dimension of said triangular matrix data (303, Fig. 3; 502, Fig. 5; lines 17-18 of page 21);

fitting a first triangular portion of said triangular matrix data into a first location relative to data of said square portion (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22); and

fitting a second triangular portion of said triangular matrix data into a second location relative to data of said square portion (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22),

wherein said first triangular portion, said second triangular portion, and said square portion fit together to form said rectangular data structure (300, Fig. 3),

wherein said hybrid full-packed data structure provides a rectangular full format data structure for an entirety of said triangular matrix data (300, Fig. 3) and said triangular matrix comprises a triangular or symmetric/Hermitian matrix.

10. (Rejected) An apparatus (Fig. 6, lines 7-19 of page 31) for linear algebra processing, said apparatus comprising:

a processor (611, Fig. 6) for processing a matrix data of a triangular matrix in at least one dense linear algebra (DLA) matrix subroutine designed to process matrix data in a full format (lines 3-7 and 10-12 of page 16), using a hybrid full-packed data structure (300, Fig. 3), said DLA matrix subroutine having been modified to process matrix data using said hybrid full-packed data structure (402, Fig. 4; steps 509,510 of Fig. 5; line 10 of page 15 through line 2 of page 16); and

a receiver (618, Fig. 6) for receiving said triangular matrix data, said processor further converting said triangular matrix data into said hybrid full-packed data structure (step 401, Fig. 4; steps 501-507 of Fig. 5; lines 8-10 of page 16),

wherein said hybrid full-packed data structure comprises:

a square portion of said triangular matrix data (303, Fig. 3; 502, Fig. 5; lines 17-18 of page 21);

a first triangular portion of said triangular matrix data (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22); and

a second triangular portion of said triangular matrix data (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22),

wherein said square portion, said first triangular portion, and said second triangular portion are fitted together to form said rectangular data structure (300, Fig. 3), and

wherein said hybrid full-packed data structure provides a rectangular data structure for an entirety of said triangular matrix data (300, Fig. 3) and said triangular matrix comprises a triangular or symmetric/Hermitian matrix.

18. (Rejected) A method of providing a service, including at least one of:

at least one of solving and applying a scientific/engineering problem (lines 7-10 of page 35);

providing a consultation related thereto (lines 10-13 of page 35);

transmitting a result of said at least one of solving and applying a scientific/engineering problem on at least one of a network, a signal-bearing medium containing machine-readable data representing said result, and a printed version representing said result (lines 13-14 of page 35); and

receiving a result of said at least one of solving and applying a scientific/engineering problem on at least one of a network, a signal-bearing medium containing machine-readable data representing said result, and a printed version representing said result, to be forwarded to a client (lines 13-14 of page 35),

wherein said at least one of solving and applying a scientific/engineering problem-comprises at least one of:

using a dense linear algebra (DLA) software package that computes one or more matrix subroutines, wherein said linear algebra software package processes a matrix data of a triangular matrix format matrix, using a full-packed data structure (300, Fig. 3), in at least one full-format matrix subroutine, as modified to use said full-packed data structure (402, Fig. 4; steps 509,510 of Fig. 5; line 10 of page 15 through line 2 of page 16),

wherein said hybrid full-packed data structure provides a rectangular data structure for an entirety of data of a triangular matrix (300, Fig. 3), said rectangular data

structure allowing said triangular data to be stored in a smaller memory space and allowing said processing to execute more efficiently (lines 9-10 of page 3 and lines 9-18 of page 5),

wherein said hybrid full-packed data structure comprises:

a square portion of said triangular matrix data (303, Fig. 3; 502, Fig. 5; lines 17-18 of page 21);

a first triangular portion of said triangular matrix data (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22); and

a second triangular portion of said triangular matrix data (304, Fig. 3; 507, Fig. 5; lines 5-7 of page 22),

wherein said square portion, said first triangular portion, and said second triangular portion are fitted together to form said rectangular data structure (300, Fig. 3).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Appellants present the single following ground for review:

GROUND 1: The Non-statutory Subject Matter Rejection for Claims 1, 4-6, 10, 13-15, 18, 19, and 26-28.

VII. ARGUMENTS

The Examiner's Position

The Examiner maintains that the present invention is directed to non-statutory subject matter for all pending claims.

In paragraph 7 beginning on page 3 of the Office Action mailed on June 20, 2007, the Examiner responded to Appellants' arguments, as follows:

"*The examiner respectfully submits that the reduction in memory is an intended use of the method of converting to full-packed structured data. It is not a necessary specific practical application of the method. It is not a practical application nor tangible final result of calculation. In general, the claims are drafted so broadly to preempt every substantial practical application of the idea embodied by the claim which is covering the triangular matrix into the rectangular matrix for processing and there is nothing in the*

claims that breathes sufficient life and meaning into the preamble so as to limit it to a particular practical application rather than being so broad and sweeping as to cover every substantial practical application of the idea embodied therein."

In the Advisory Action mailed on September 10, 2007, the Examiner further states:

"The applicant extensively argues in pages 10-14 for claims rejected under 35 U.S.C. 101 that the claims are direct[ed] to statutory subject matter as useful, concrete, and tangible wherein the applicant argues that the limitation "reduce a memory [space] requirement and to increase a processing efficiency" is [sufficient] for useful, concrete, and tangible result.

The examiner respectfully submits that the limitation above is not cited in every independent [claim]. Currently, the claims do not disclose any physical/practical application of having a hybrid full-packed data structure in linear algebra processing. Therefore, the previous 101 rejection is maintained."

Appellants' Position on the Non-Statutory Subject Matter Rejection

In response, Appellants respectfully submit that the above-recited rationale by the Examiner includes a number of points of confusion relative to patent law and statutory subject matter.

First, Appellants respectfully submit that the claimed invention is clearly defined in a very limited application, since it clearly addresses a novel data rearrangement format in the specific application as a preliminary step in matrix processing. The method of data rearrangement into the novel data structure is not even attempting to claim any other possible application of data rearrangement.

That is, Appellants submit that, if anything, the underlying idea of rearranging data (e.g., into a rectangular data structure) is being applied specifically in the environment of triangular/symmetrical matrix data and only as a preliminary step prior to matrix processing. Therefore, Appellants respectfully traverse the Examiner's characterization that the claimed invention is preempting an abstract idea such as "rearranging data", since the claimed invention applies this abstract idea into a very specific application involving only triangular/symmetrical matrix data and applies it only as a preliminary data rearrangement for matrix processing.

Second, relative to the characterization that "*... the claims are drafted so broadly to preempt every substantial practical application of the idea embodies by the claim which is covering the triangular matrix into the rectangular matrix for processing ....*", Appellants point out that all patent claims inherently preempt something, and, indeed, this is precisely the function of a patent claim.

In the present invention and taking claim 1 as an example, the claims are intended to provide patent protection for the method of reducing memory space and possibly increasing processing efficiency or using the same amount of space and increasing the processing efficiency by a factor of 1 to 100, as that method is then defined in the claim limitations. Appellants have recognized that triangular matrix data, as conventionally stored in memory, takes up more memory than necessary to preserve the information content and causes processing inefficiency by requiring that the redundant information also be processed. The inventors realized that the essential data, which is triangular-shaped from the perspective of matrices, could be stored in a novel rectangular format of about one half size of the original complete matrix data and could be processed faster if this essential data only (e.g., not also including the redundant or packed data section) is presented for processing. Moreover, existing matrix subroutines can be used as long as the calling sequence is modified to accommodate the data relocations.

The only thing preempted by the present invention is a specifically-defined method of reducing memory and increasing processing efficiency for matrix processing, only for triangular/symmetrical matrix data, and only when done as a preliminary conversion of triangular or symmetrical matrix data into the novel rectangular format as described in the independent claims. There may very well be another method to achieve similar savings in space and processing efficiency, and Appellants believe that others will be motivated to discover other possible techniques by understanding the principles of the present invention.

There is no preemption of normal processing of matrix data stored in the conventional full format, should one choose to tolerate the possible slower speed and larger (e.g., double) memory requirement.

That is, there is no preemption of the processing of triangular/symmetrical matrix data using the conventional storage that takes up twice as much memory and is inefficient of memory usage. The present invention simply provides an alternative method that is twice as efficient. There may be other ways that also provide similar efficiency.

Nor is there preempting by the present invention for the processing of the conventional standard packed format in which the user must tolerate the possible slow performance and the same memory requirement. The present invention provides an alternative that is 1 to 100 times faster using the same amount of memory.

And, to the extent that the present invention is considered to preempt the conventional matrix processing subroutines (which can be used for processing the converted matrix data), that preemption occurs only in combination with the preliminary conversion from triangular data into a specific rectangular data structure.

Appellants submit that the Examiner's confusion with "preemption" is perhaps related to the misunderstanding that all patents are inherently intended to preempt something. That "something" depends upon the object and environment of the invention and different inventions require different wording to provide protection. The "something" of the present invention is related to the machine doing the matrix processing by its having prearranged the input data and then using unmodified linear algebra processing modules to execute the processing (with different calling parameters). This approach is clearly novel, as evidenced by the lack of a prior art rejection.

The Examiner is seemingly confusing the word "preemption" with "abstraction" or "abstract idea." Appellants submit that "abstract idea" has never been equivalent to "preemption" in the sense that the Office is entitled to declare that an invention is an abstract idea because the claims preempt something. Of course a claim will preempt something: that is its purpose.

"Preemption" in modern patent case law relates to the issue of whether a mathematical algorithm is being preempted by a patent and is not directed to precluding the exclusive use of a method in all possible applications of that method, as the Examiner

seemingly perceives. The claims address a method that improves matrix processing in a computer, not any specific use for which matrix processing might happen to be useful.

In the present invention, there is no mathematical algorithm being claimed, since the method relates to a preliminary reorganizing of triangular/symmetrical matrix data originally stored in a conventional manner. The present invention does not preempt a mathematical algorithm even if there were dependent claims directed to the matrix processing itself, since the underlying "mathematical algorithm" (e.g., the matrix procedure, if this is considered to be a "mathematical algorithm") can still be executed using the originally-stored data and the original matrix subroutines (e.g., it just takes longer and requires more space in memory). Indeed, the present invention utilizes the standard matrix subroutines as modified only for a different calling sequence. Moreover, even if dependent claims were to be directed to processing the matrix operation itself, the only preemption that would result is the preemption using the defined preliminary data rearrangement.

Relative to the Examiner's position that the claims must limit the method to a specific application, Appellants respectfully disagree that the patent system was ever intended to have this constraint. Again, Appellants submit that the method addresses an improvement in matrix processing, not a method of any specific application for which matrix processing could be used. As described in the specification, there are virtually an unlimited number of applications that use matrix processing, including many scientific and engineering problems.

As best understood, this Examiner expects a patent claim to limit a method related to a processing that clearly has wide "practical applications" to only one or two such applications of the processing. As mentioned above, the intent of patent law is to grant the right to exclude the use of a patented method by others and would include all uses.

Taking the Examiner's attempt to limit the uses, such requirement would correspond to a requirement that an improvement providing memory reduction/processing efficiency for a word processing program, for example, be limited for only the application wherein the word processor is used for writing letters, for example, and would not protect

the improvement when the word processor is used, for example, for writing business reports or academic papers. Appellants submit that there is no requirement in US patent law that require that the appellant artificially limit the claimed invention to specify which "practical applications" the method is protected by the patent and such artificial limitation contradicts the purpose of patent law to provide protection for all uses of the method, if that method has multiple uses.

In this example with the word processor improvement, the improvement would relate to the word processing application program itself, not to specific applications for which the word processing application program could be used. Similarly, the present invention relates to the actual processing of many matrix operations on a machine (e.g., those operations involving triangular/symmetrical matrix data), not to one or a few of the many practical applications in which any of these matrix operations could possibly be involved.

That is, relative to the present invention, the method is directed to the real-world application of managing data in the computer, prior to its being presented for matrix processing. Although matrix processing has many real-world applications, as clearly explained in the disclosure, the "practical application" of the present invention is actually directed to the manner in which the machine processing the matrix procedure performs its functions (e.g, improved memory usage and improved efficiency), not the result that might be obtained by applying matrix theory and the matrix procedure being performed for any specific real-world problem or application. Thus, Appellants respectfully submit that the Examiner's analysis is attempting to look to the wrong "result."

Appellants further respectfully submit that the underlying flaw of the Examiner's position is that the analysis currently of record arbitrarily re-defines the present invention with this particular Examiner's preferred choice of wording, clearly in an attempt to characterize it as directed to non-statutory subject matter. That is, according to the Examiner's analysis, the reduction of memory space is the "intended use" of the conversion to full-packed data and the improvement of processing efficiency is the "benefit" of the method.

In response, Appellants submit that the conversion to the full-packed data format defines the method of the invention and the reduction in memory space/processing efficiency is inherently the result of this method. Even if the Examiner wishes to arbitrarily describe the memory reduction/processing efficiency as being the "intended use/benefit", there is nothing that precludes this "intended use/benefit" as also constituting the useful, concrete and tangible result of the method.

That is, "intended use/benefit" is not mutually exclusive to "inherent result." Indeed, Appellants submit that the words "intended use/benefit" are closely related to the word "result", in the sense that the Examiner uses these characteristics. Appellants respectfully submit that arbitrarily choosing to use the words "intended use" and "benefit" is an arbitrary preference of the Examiner and, when used as an alternative to "result", does not preclude the memory space reduction/ processing efficiency improvement as also being the "useful, concrete and tangible result" of the invention.

Stated slightly differently, the Examiner does *not* dispute that the present invention reduces memory and improves processing efficiency. Nor does the Examiner dispute Appellants' contention that such memory reduction/processing efficiency improvement is useful, concrete and tangible. Indeed, Appellants submit that such memory reduction/ processing improvement is *inherently* a result of the described computerized method and is, therefore, *inherently* useful, concrete and tangible.

Therefore, again, Appellants submit that the Examiner is attempting to focus on the wrong "result' in the statutory subject matter issue, since the result of significance is the improvement of efficiency and memory utilization in the matrix processing operation, not the result provided by the end processing of the matrix data itself.

Moreover, Appellants respectfully submit that, as a matter of law, this inherent result of the present invention, when claimed as a computerized process, is all that is necessary to satisfy the requirement for statutory subject matter and that it is irrelevant that a particular Examiner arbitrarily considers the inherent result of the computerized method as also being an intended use or a benefit of the method.

Finally, since there is no mathematical algorithm being preempted by the method of the present invention, the "useful, concrete and tangible result" test applies only to the method claims, at most. The apparatus and Beauregard claims would not even be subject to such analysis and are clearly statutory.

Therefore, relative to claim 15, Appellants submit that this claim is clearly addressed to "[a] machine-readable medium tangibly embodying a program of machine-readable instructions executable by a digital processing apparatus ....." Such claims are "Beauregard claims", after *In re Beauregard*, 53 F.3d 1583 (Fed. Cir.,1995), wherein the USPTO Commissioner conceded that such claims are indeed statutory subject matter because they are articles of manufacture. US Patent No. 5,710,578 to Beauregard, et al., issued on January 20, 1998.

Relative to claims 10, 13, and 14, these claims are directed to an apparatus and are, therefore, clearly directed to a machine, one of the four categories explicitly identified in 35 USC §101.

Relative to the method claims, as particularly described in amended independent claim 1, the present invention does indeed have the prerequisite practical application and tangible result (wherein "tangible" means "real-world") because it permits a reduction in memory space for the data and an improvement in calculating the matrix operation.

Moreover, since the method steps are directed to the preliminary state of the machine performing the processing, Appellants submit that it is not even subject to the "useful, concrete and tangible result" test, since it is not directed to the actual processing of the matrix operation itself.

Therefore, the present invention is not merely manipulating data in the abstract nor even claiming the processing of the matrix mathematical operation in the abstract. Rather, as explained during the telephone interview, the present invention solves a long standing dense linear algebra problem of having two data structures (full and packed) for triangular (i.e., triangular or symmetric/Hermitian) matrices by eliminating the packed data structure, as explained on page 10 of the specification. The packed format uses half the storage but performs one to a hundred times slower than matrix processing algorithms written for the

full format, whereas the full format uses twice the storage of packed and performs better or the same.

The present invention converts the packed or full data structure of symmetric or Hermitian/triangular matrix data into a hybrid full data structure (e.g., different from the standard full data structure). This hybrid full data structure saves half the memory storage compared to the full matrix data format and can be used with the unchanged, faster full format processing, as modified to accommodate this hybrid full format subroutine processing only by changing calling sequences.

For the reasons stated above, the claimed invention is clearly directed toward statutory subject matter, and the Board is respectfully requested to reconsider and withdraw this rejection.

IX. CONCLUSION

In view of the foregoing, Appellants submit that claims 1, 4-6, 10, 13-15, 18, 19, and 26-28, all the claims presently pending in the application, are clearly directed to statutory subject matter and patentably distinct from any prior art of record and in condition for allowance. Thus, the Board is respectfully requested to remove all rejections of claims 1, 4-6, 10, 13-15, 18, 19, and 26-28.

Please charge any deficiencies and/or credit any overpayments necessary to enter this paper to Assignee's Deposit Account number 50-0510.

Respectfully submitted,

Dated: November 19, 2007

Frederick E. Cooperrider
Reg. No. 36,769

McGinn Property Law Group, PLLC
8231 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer Number: 21254

CLAIMS APPENDIX

The claims, as reflected upon entry of the Supplemental Amendment Under 37 CFR §1.111 filed on May 21, 2007, are shown below:

1. (Rejected) A method to at least one of reduce a memory space requirement and to increase a processing efficiency in a computerized method of linear algebra processing, said method comprising:

providing a hybrid full-packed data structure for processing data of a triangular matrix by one or more dense linear algebra (DLA) matrix subroutines designed to process matrix data in a full format, as modified to process matrix data using said hybrid full-packed data structure; and

converting said data from said triangular matrix into said hybrid full-packed data structure, as follows:

determining a portion of said triangular matrix data that would comprise a square portion having a dimension approximately one half a dimension of said triangular matrix data;

fitting a first triangular portion of said triangular matrix data into a first location relative to data of said square portion; and

fitting a second triangular portion of said triangular matrix data into a second location relative to data of said square portion,

wherein said first triangular portion, said second triangular portion, and said square portion fit together to form said rectangular data structure,

wherein said hybrid full-packed data structure provides a rectangular full format data structure for an entirety of said triangular matrix data and said triangular matrix comprises a triangular or symmetric/Hermitian matrix.

2-3. (Canceled)

4. (Rejected) The method of claim 1, wherein said matrix subroutine designed to process matrix data in said full format comprises a matrix subroutine of a LAPACK (Linear Algebra PACKage) software package.

5. (Rejected) The method of claim 4, wherein said matrix subroutine comprises a variant of a corresponding full format routine of a level 3 BLAS (Basic Linear Algebra Subroutine).

6. (Rejected) The method of claim 5, wherein said level 3 BLAS comprises an L1 kernel routine,

wherein L1 comprises an L1 cache in a computer, said L1 cache comprising a cache closest to one of a CPU (Central Processing Unit) and an FPU (Floating-Point Processing Unit) in said computer.

7-9. (Canceled)

10. (Rejected) An apparatus for linear algebra processing, said apparatus comprising:

a processor for processing a matrix data of a triangular matrix in at least one dense linear algebra (DLA) matrix subroutine designed to process matrix data in a full format, using a hybrid full-packed data structure, said DLA matrix subroutine having been modified to process matrix data using said hybrid full-packed data structure; and

a receiver for receiving said triangular matrix data, said processor further converting said triangular matrix data into said hybrid full-packed data structure,

wherein said hybrid full-packed data structure comprises:

a square portion of said triangular matrix data;

a first triangular portion of said triangular matrix data; and

a second triangular portion of said triangular matrix data,

wherein said square portion, said first triangular portion, and said second triangular portion are fitted together to form said rectangular data structure, and

wherein said hybrid full-packed data structure provides a rectangular data structure for an entirety of said triangular matrix data and said triangular matrix comprises a triangular or symmetric/Hermitian matrix.

11-12. (Canceled)

13. (Rejected) The apparatus of claim 10, wherein said at least one matrix subroutine designed to process matrix data in a full format comprises at least one level 3 BLAS (Basic

Linear Algebra Subroutine) or a matrix subroutine of a LAPACK (Linear Algebra PACKage) or a comparable software package.

14. (Rejected) The apparatus of claim 13, wherein said processor comprises one of a CPU (Central Processing Unit) and an FPU (Floating-Point Processing Unit), said apparatus further comprising:

an L1 cache, said L1 cache comprising a cache closest to said CPU or said FPU,

wherein said level 3 BLAS comprises an L1 kernel routine.

15. (Rejected) A machine-readable medium tangibly embodying a program of machine-readable instructions executable by a digital processing apparatus to perform

the method of claim 1.

16-17. (Canceled)

18. (Rejected) A method of providing a service, including at least one of:

at least one of solving and applying a scientific/engineering problem;

providing a consultation related thereto;

transmitting a result of said at least one of solving and applying a scientific/engineering problem on at least one of a network, a signal-bearing medium containing machine-readable data representing said result, and a printed version representing said result; and

receiving a result of said at least one of solving and applying a scientific/engineering problem on at least one of a network, a signal-bearing medium containing machine-readable data representing said result, and a printed version representing said result, to be forwarded to a client,

wherein said at least one of solving and applying a scientific/engineering problem-comprises at least one of:

using a dense linear algebra (DLA) software package that computes one or more matrix subroutines, wherein said linear algebra software package processes a matrix data of a triangular matrix format matrix, using a full-packed data structure, in at least one full-format matrix subroutine, as modified to use said full-packed data structure,

wherein said hybrid full-packed data structure provides a rectangular data structure for an entirety of data of a triangular matrix, said rectangular data structure allowing said triangular data to be stored in a smaller memory space and allowing said processing to execute more efficiently,

wherein said hybrid full-packed data structure comprises:

a square portion of said triangular matrix data;

a first triangular portion of said triangular matrix data; and

a second triangular portion of said triangular matrix data,

wherein said square portion, said first triangular portion, and said second triangular portion are fitted together to form said rectangular data structure.

19. (Rejected) The method of claim 18, wherein said linear algebra software package comprises a Linear Algebra PACKage (LAPACK) or comparable software package.

20-25. (Canceled)

26. (Rejected) The method of claim 1, wherein said triangular matrix data comprises matrix data in a triangular packed format, said hybrid full-packed data structure thereby allowing a faster processing using a modified full format DLA matrix subroutine than is possible using a packed format DLA matrix subroutine.

27. (Rejected) The method of claim 1, wherein said triangular matrix data comprises matrix data in a triangular full format, said hybrid full-packed data structure thereby allowing a reduction in required memory space by about 100% compared to said triangular full format data.

28. (Rejected) The method of claim 26, said hybrid full-packed data structure thereby providing a means to eliminate a necessity that processing triangular matrix data in a packed format must be executed by slower DLA subroutines designed for said packed format.

EVIDENCE APPENDIX

None

RELATED PROCEEDINGS APPENDIX

None